
A BEHAVIOURAL STUDY OF SMALL SKIPPER *THYMELICUS SYLVESTRIS* PODA AND ESSEX SKIPPER *THYMELICUS LINEOLA* OCHS. BUTTERFLIES (LEP: HESPERIIDAE)

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Abstract

Most butterfly studies and monitoring programmes do not differentiate between Small Skipper *Thymelicus sylvestris* Poda and Essex Skipper *Thymelicus lineola* Ochs. Therefore, combined information is predominantly presented and understanding of their behavioural activity is limited. This paper examines the behavioural patterns exhibited by the two species. Both primarily spent their time basking, resting and nectaring. Plant species used for nectaring purposes by *T. sylvestris* and *T. lineola* are listed.

Introduction

The primary cause of butterfly population declines has been the destruction and alteration of their habitats (Prendergast & Eversham, 1995), particularly in south-eastern England, where agriculture is most intensive and development pressure on semi-natural areas greatest (Pollard & Yates, 1993). However, agricultural areas can provide sufficient semi-natural habitats to support some butterflies (Sparks & Parish, 1995) and the more successful species are those which can breed within the farming landscape (Feber *et al.*, 1996).

Larval foodplants used by Small Skipper *Thymelicus sylvestris* Poda and Essex Skipper *Thymelicus lineola* Ochs. consist of various species of grasses (Graminea), thus adults breed in areas of tall grassland such as meadows (Warren, 1996), which can be found within agricultural environments. Other grassland habitats including woodland rides, embankments and roadside verges are also exploited by these species (Thomas & Lewington, 1991) and both *T. sylvestris* and *T. lineola* are consequently experiencing periods of expansion in range due to the extensive availability of suitable grassland habitats (Asher *et al.*, 2001). However, *T. lineola* is difficult to distinguish from *T. sylvestris* when in flight and has thus been included in combined data with the latter species (Pollard *et al.*, 1995), and potentially remains under-recorded.

Despite being classified as widespread species (Pollard & Yates, 1993), limited quantitative research has been completed on *T. sylvestris* and *T. lineola* behavioural activity. Therefore, a study of these species, which distinguishes between *T. sylvestris* and *T. lineola*, was conducted on the Writtle College Estate focusing on behavioural patterns. Observations of *T. sylvestris* and *T. lineola* behavioural activity were recorded at three sites: Spinney Verge, Tip Meadow and Lordships Pond. These sites were selected because they provide refuges of semi-natural grassland within the predominantly agricultural environment of the Estate.

Site Descriptions

Writtle College is located in south-eastern England, near Chelmsford in Essex. The College Estate extends to over 210 hectares and is a mixed unit comprising horticultural enterprises, arable land and improved grassland for livestock; offering restricted value as wildlife habitats (Woiwod & Stewart, 1990). The creation of conservation areas throughout the Estate since the mid 1970s, however, has resulted in a landscape which has a number of valuable sites for wildlife within the agricultural environment (Sellers & Field, 1997). The conservation areas include broadleaf plantations, wildflower meadows and re-instated hedgerows. The sites selected for this study are designated by the College as areas of conservation interest and are known to be utilised by populations of both skipper species. Figure 1 displays the location of the three study sites on the Estate.

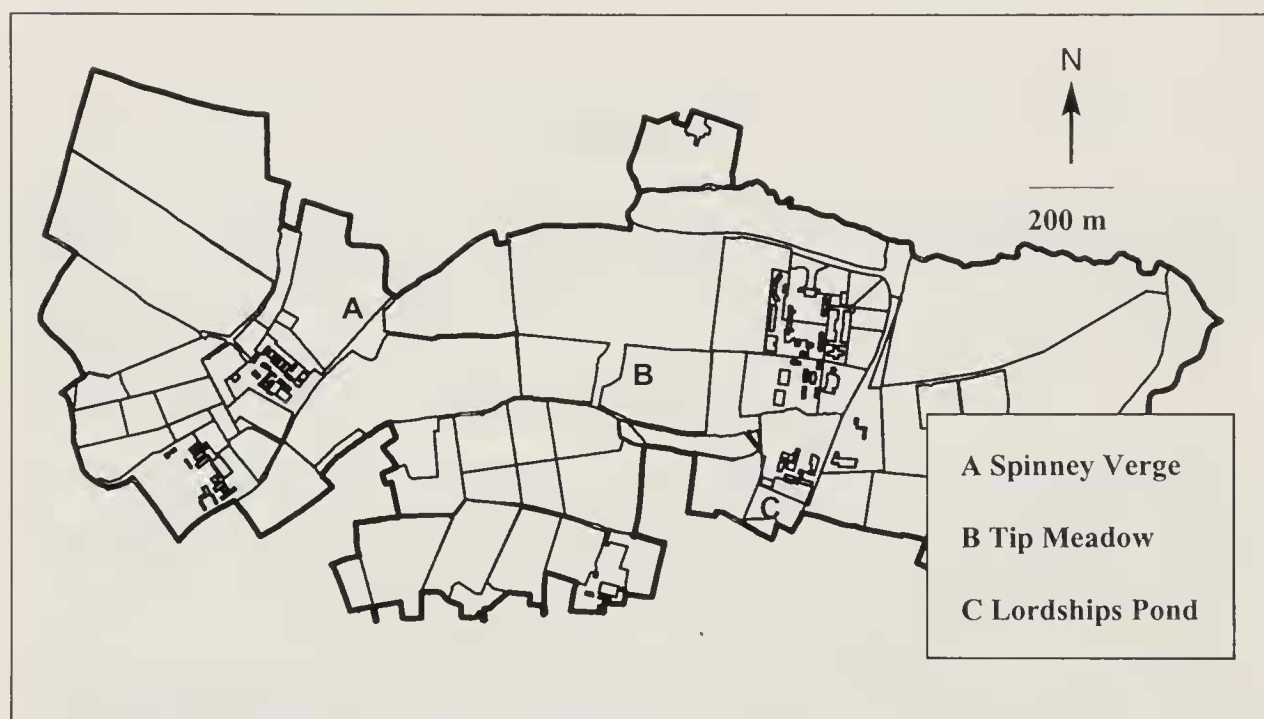


Figure 1. Location of the three study on the Writtle College Estate.

Spinney Verge (O.S. grid reference TL 665070) comprises an area of approximately 500 square metres. The verge is bordered by a Hawthorn *Crataegus monogyna* Jacq. dominated hedgerow on its western side and the road to the east. The hedgerow provides some shelter from the prevailing south-westerly winds. This rural verge was created by the removal of calcareous clay loam topsoil to enhance visibility, where high roadside banks had previously been obscuring vision. The exposed chalky subsoil is well drained with a pH around 8 (Anon, 1998). A wide range of flowering plants has established on the low nutrient subsoil, including some interesting species such as Bee Orchid *Ophrys apifera*. The verge is mechanically cut, on an annual basis, at the beginning of October and the cuttings are immediately removed.

Tip Meadow (TL 672069) is approximately 11,250 square metres in size. The soil is a well drained flinty clay loam with a pH just over 8 (Anon, 1998). The tip was formally a gravel pit (Neate, 1979), which has since been filled with refuse and soil to create a conservation area. The area comprises a wildflower meadow which is managed under a traditional hay regime, a large beetle bank, a section of long rough grassland, and planted broadleaved trees and shrubs with the occasional Scot's Pine *Pinus sylvestris* L. Land uses surrounding the Tip Meadow area include commercial orchards, permanent pasture, arable trial plots with a section of game cover and set-aside grassland. The behavioural study was conducted in the long rough grassland which undergoes little management other than irregular mowing.

Lordships Pond (TL 676066) has been a drinking source for cattle since at least 1840. The pond abuts a recently created wildflower meadow. The behavioural study was conducted on a south facing bank which is approximately 350 square metres in size. The soil is a non-calcareous clay loam which is moderately well drained with a pH around 6.5 (Anon, 1998). Mature *P. sylvestris* surrounding the pond provide the bank with some shelter. Management of the bank consists of irregular mowing and the manual removal of *P. sylvestris* and Bramble *Rubus fruticosus* L.

Behavioural Study

A survey area of 25 square metres was established at each of the three study sites. All plant species within the survey areas were identified and recorded. The abundance of each plant species was determined using the DAFOR scale, which is a subjective assessment based on occurrence with the code: D = Dominant, A = Abundant, F = Frequent, O = Occasional, R = Rare (Goldsmith, 1991).

The duration of all of the different activities completed by *T. sylvestris* and *T. lineola* individuals entering the survey areas during observation sessions were timed over a period of 12 days between 15 July and 6 August 1999. The activities observed for individuals of both species during the study period were basking (alighted with wings open), resting (alighted with wings folded), nectaring, territorial behaviour between males, courtship, copulation, oviposition, interaction with other butterfly species, and flight. Flight was timed for individuals which passed through the survey areas without alighting, and from take-off to the next landing between other activities for individuals which demonstrated multiple activities.

Individuals which were observed utilising the survey areas were netted to differentiate between *T. sylvestris* and *T. lineola* by antennal colour, and to distinguish gender. Where any doubt arose with regard to identification, the specimen was released and behavioural activities were not recorded. The procedure of capture and release was undertaken as quickly as possible to minimise its effects. The first activity observed following release was disregarded to accommodate recovery time following the netting process (Warrington & Brayford, 1995) and to avoid bias resulting from different handling periods and varying release localities within the survey areas.

One hour was spent observing *T. sylvestris* and *T. lineola* individuals at each site on every recording day. The devised behavioural study procedures were validated by

utilising recording criteria from the National Butterfly Monitoring Scheme (NBMS). The NBMS is organised by the Centre for Ecology and Hydrology at Monks Wood and was established in 1976 with the aim of providing information on trends in the abundance of butterfly species (Asher *et al.*, 2001). Surveys were only conducted between 1045 and 1545 hours, on days where air temperature exceeded 17°C and wind speed was equal to or less than force 5 on the Beaufort scale (Pollard *et al.*, 1986). Wind speed was estimated using the description provided by the Beaufort scale to obtain a force rating (File, 1991).

Results

Both *T. sylvestris* and *T. lineola* individuals were observed exhibiting patterns of daily behavioural activity on each of the 12 recording days which represent the duration of the four-week study period (Fig. 2). Initially, *T. sylvestris* were more abundant than *T. lineola*, however, this trend reversed towards the end of the study period. The number of *T. sylvestris* individuals that were observed peaked at 31 sightings on 23 July, before gradually declining throughout the remainder of the study period. Observations of *T. lineola* individuals were limited at the study commencement, but progressively increased to reach a peak of 26 sightings on 30 July, one week later than the maximum number of *T. sylvestris* individuals that were observed occurred. Overall, *T. lineola* was slightly more abundant than *T. sylvestris*, with total sightings for the study period of 201 and 183 respectively.

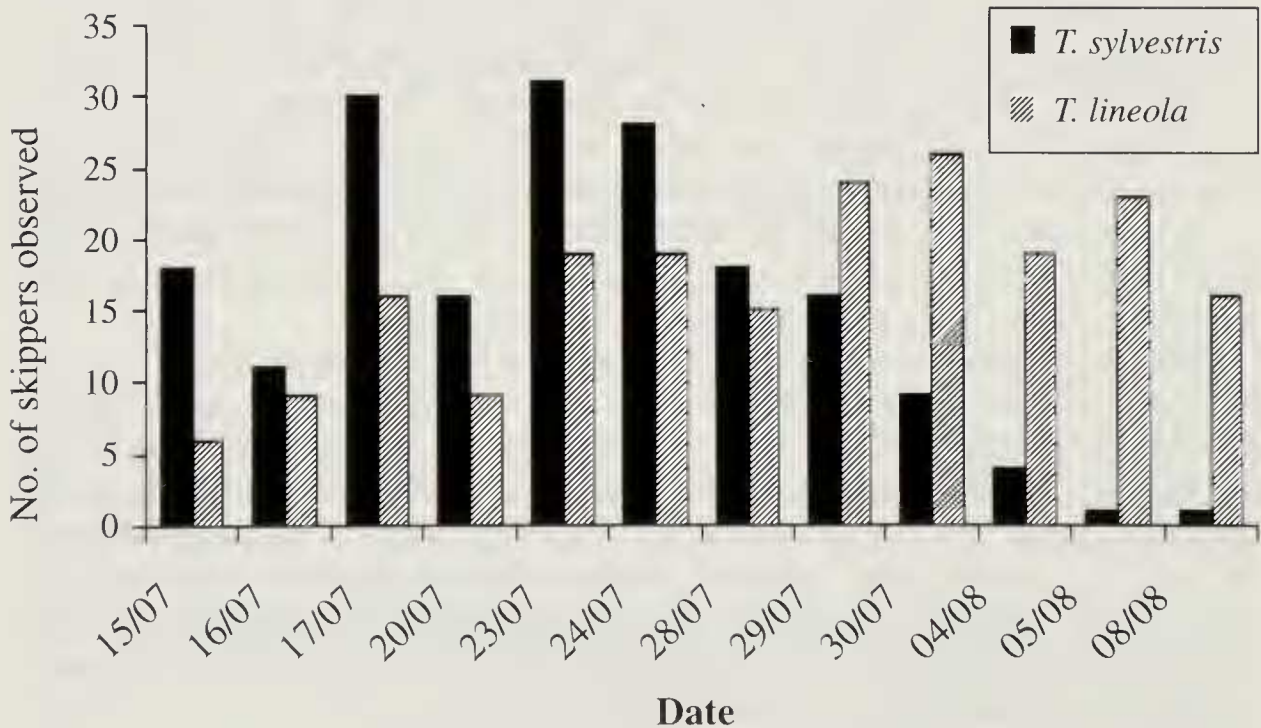


Fig. 2. Number of *T. sylvestris* and *T. lineola* individuals observed on each recording day.

Figure 3 demonstrates that *T. sylvestris* individuals spent longer resting and flying than *T. lineola* individuals completing these activities. However, *T. lineola* individuals exceeded their *T. sylvestris* counterpart for time spent basking, nectaring and completing the other combined behavioural activities. The behavioural activity of both *T. sylvestris* and *T. lineola* individuals was dominated by nectaring, although the preferred species varied.

The proportional duration of time spent nectaring by both *T. sylvestris* and *T. lineola* varied on each different plant species (Table 1). For their time spent nectaring, *T. sylvestris* individuals used Black Knapweed *Centaurea nigra* L. for the longest duration, followed by Black Horehound *Ballota nigra* L. Conversely, *T. lineola* individuals spent more time nectaring on *B. nigra* than on *C. nigra*, but these two plant species consumed the majority of the total nectaring time for both skipper species. Lesser Burdock *Arctium minus* Hill and Red Clover *Trifolium pratense* L. were also important nectar sources for *T. sylvestris* and *T. lineola* respectively.

Table 1. Proportional duration of nectaring on each plant species used by *T. sylvestris* (Ts) and *T. lineola* (Tl)

Plant species	Ts nectaring duration (%)	Tl nectaring duration (%)
<i>Arctium minus</i>	13.65	5.73
<i>Ballota nigra</i>	26.40	49.01
<i>Centaurea nigra</i>	47.17	20.61
<i>Centaureum erythraea</i>	1.71	—
<i>Cirsium arvense</i>	0.90	0.77
<i>Convolvulus arvensis</i>	0.69	—
<i>Knautia arvensis</i>	0.94	2.70
<i>Medicago sativa</i>	5.34	7.72
<i>Prunella vulgaris</i>	0.86	0.70
<i>Trifolium pratense</i>	2.36	12.77

Some of the plant species used for nectaring purposes were only utilised by one of the skipper species or by one individual. For comparative purposes, Figs. 4 and 5 illustrate the mean duration in seconds of visits recorded to those plant species which were utilised by more than one individual of both skipper species. At Spinney Verge (Fig. 4), visits for nectaring purposes completed by *T. sylvestris* individuals were longest on *C. nigra*, subsequently followed by Field Scabious *Knautia arvensis* L., whereas *T. lineola* individuals made longer visits to *T. pratense* and Lucerne *Medicago sativa* L. at this site.

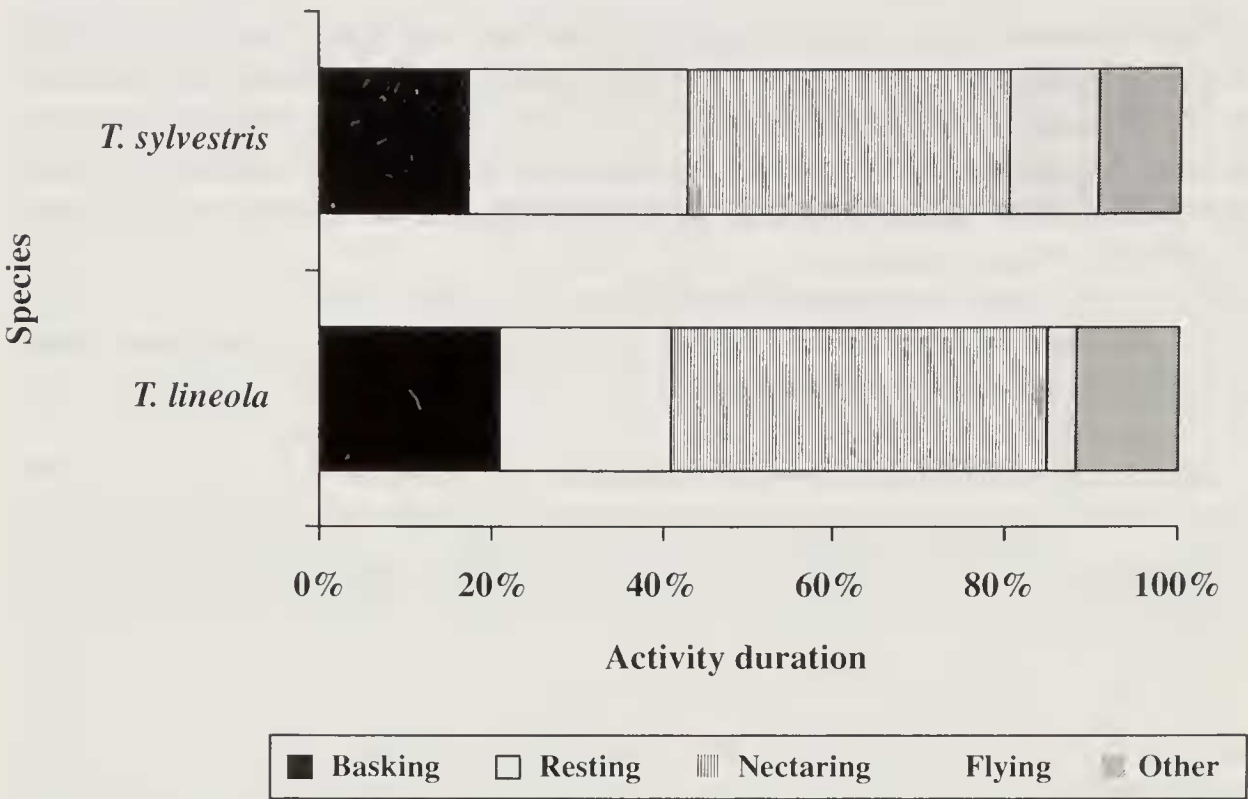


Fig. 3. Proportional duration of *T. sylvestris* and *T. lineola* total observation time spent completing selected behavioural activities.

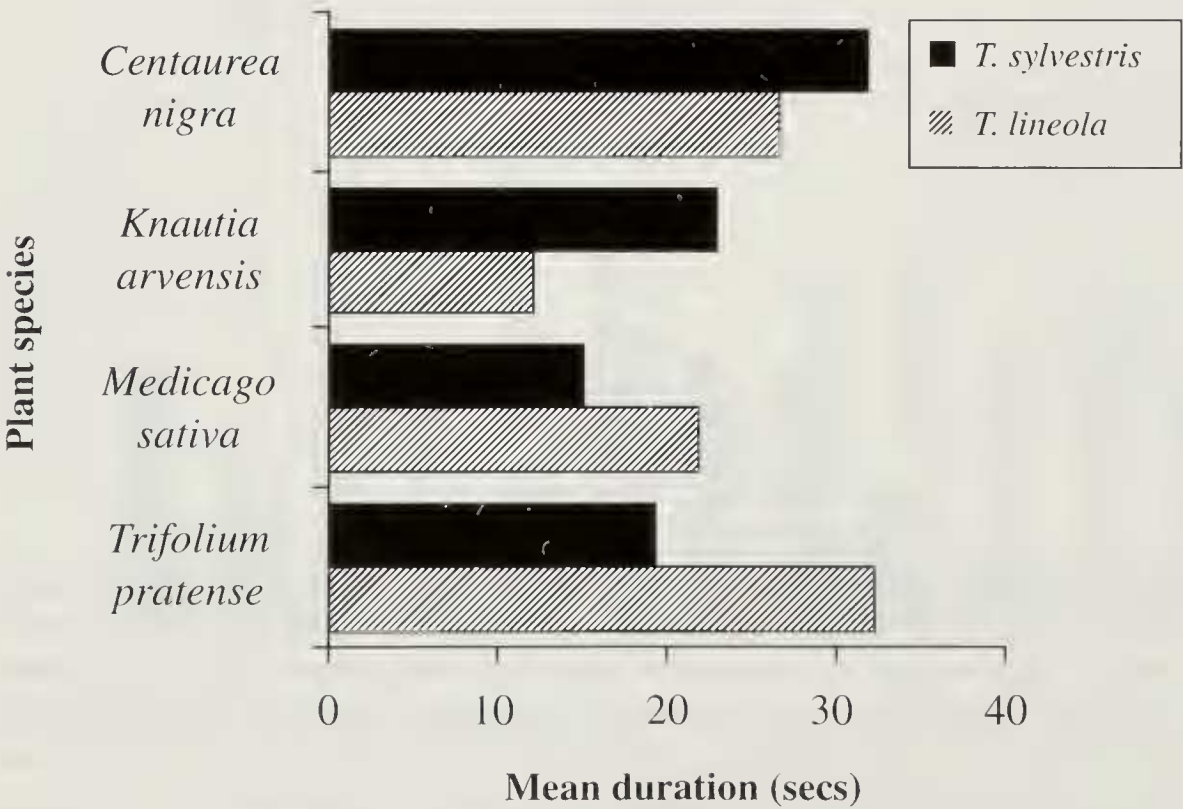


Fig. 4. Mean duration of time spent nectaring on plant species at Spinney Verge by *T. sylvestris* and *T. lineola*.

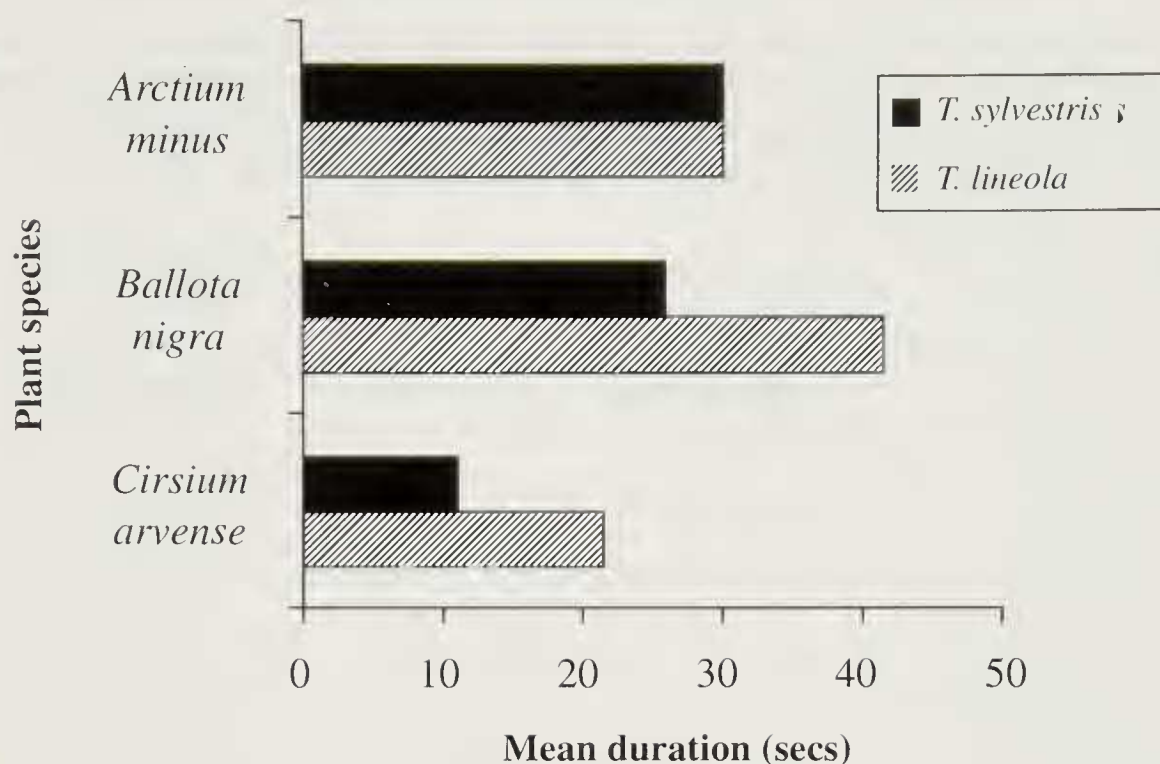


Fig. 5. Mean duration of time spent nectaring on plant species at Tip Meadow by *T. sylvestris* and *T. lineola*.

Mean duration of visits to *A. minus* at Tip Meadow (Fig. 5) were identical for both *T. sylvestris* and *T. lineola* individuals, and were the longest visits made for nectaring by the former skipper species. *B. nigra* procured the longest mean visit time for nectaring by *T. lineola* individuals (over 40 seconds), followed by *A. minus*, and then by Creeping Thistle *Cirsium arvense* L. The only plant species used for nectaring by more than one individual of both skipper species at Lordships Pond was *C. nigra*, which received longer visits by *T. sylvestris* than *T. lineola* individuals at this site.

Oviposition on grass species was infrequently recorded during the study, being observed only four times for each of the two skipper species. All four occurrences of oviposition for *T. sylvestris* were observed at Lordships Pond, where Yorkshire Fog *Holcus lanatus* L. (three observations) and False Oat-grass *Arrhenatherum elatius* L. (one observation) were the grass species utilised. *T. lineola* was observed ovipositing at both Spinney Verge and Lordships Pond, with two occurrences at each site. Two examples of oviposition were observed on *A. elatius* at Lordships Pond whilst at Spinney Verge, *T. lineola* oviposited once on both *A. elatius* and Timothy *Phleum pratense* L.

Table 2 demonstrates the abundance of plant species that were utilised for nectaring or oviposition purposes by either *T. sylvestris* or *T. lineola* at each of the three study sites. The preferred nectar and oviposition plant species were not necessarily abundant at any of the three study sites. *C. nigra* and *K. arvensis* were the preferred nectar sources for *T. sylvestris* at Spinney Verge, but neither species

occurred in abundance at this site. Although *A. minus* and *C. arvense* were the preferred nectar sources at Tip Meadow, the most abundant plant species at this site was *A. elatius*. Contrastingly, the preferred nectar source for both skippers at Lordships Pond (*C. nigra*) was one of the most abundant plant species at this site.

Table 2. DAFOR abundance values for plant species utilised for nectaring and oviposition at the three study sites.

Nectar species	Spinney Verge	Tip Meadow	Lordships Pond
<i>Arctium minus</i>	-	O	-
<i>Ballota nigra</i>	-	F	-
<i>Centaurea nigra</i>	F	-	A
<i>Centaureum erythraea</i>	F	-	-
<i>Cirsium arvense</i>	-	F	-
<i>Convolvulus arvensis</i>	-	-	F
<i>Knautia arvensis</i>	O	-	-
<i>Medicago sativa</i>	O	-	-
<i>Prunella vulgaris</i>	-	-	A
<i>Trifolium pratense</i>	A	-	-
Oviposition species			
<i>Arrhenatherum elatius</i>	F	A	F
<i>Holcus lanatus</i>	-	-	O
<i>Phleum pratense</i>	R	-	R
DAFOR scale: D (dominant) A (abundant) F (frequent) O (occasional) R (rare)			

H. lanatus was primarily selected for oviposition purposes by *T. sylvestris* at Lordships Pond. However, this grass species was not as abundant at this site as *A. elatius* which was also utilised for oviposition purposes during the study. The preferred grass species for oviposition by *T. lineola* during the study was *A. elatius*. Oviposition by *T. lineola* was observed at Spinney Verge and Lordships Pond where *A. elatius* was frequent.

The plant species which were not utilised by either skipper species for nectaring or oviposition are displayed in Table 3. Plant species such as *R. fruticosus* and Ox-eye Daisy *Leucanthemum vulgare* Lam. at Lordships Pond were not utilised for nectaring purposes by either skipper species. Similarly, at Spinney Verge the frequently occurring Agrimony *Agrimonia eupatoria* L. and Perforate St. John’s-wort *Hypericum perforatum* L. were avoided by individuals of both skipper species. Grass species such as Couch *Elytrigia repens* L. and Cock’s-foot *Dactylis glomerata* L. which were recorded at Tip Meadow were not used for oviposition purposes during the study.

Table 3. DAFOR abundance values for plant species which were not utilised by either skipper species for nectaring or oviposition

Plant species	Spinney Verge	Tip Meadow	Lordships Pond
<i>Achillea millefolium</i>	O	-	O
<i>Agrostis capillaris</i>	-	-	O
<i>A. stolonifera</i>	-	-	R
<i>Alopecurus pratensis</i>	-	O	-
<i>Anisantha sterilis</i>	-	F	-
<i>Anthoxanthum odoratum</i>	-	-	F
<i>Agrimonia eupatoria</i>	F	-	-
<i>Artemisia vulgaris</i>	-	O	-
<i>Briza media</i>	-	-	O
<i>Crataegus monogyna</i>	O	-	-
<i>Cynosurus cristatus</i>	-	-	F
<i>Dactylis glomerata</i>	-	F	-
<i>Daucus carota</i>	R	-	-
<i>Epilobium hirsutum</i>	-	-	O
<i>Elytrigia repens</i>	-	A	-
<i>Festuca arundinacea</i>	O	-	-
<i>F. rubra</i>	O	-	O
<i>Galium aparine</i>	-	O	-
<i>G. mollugo</i>	-	R	-
<i>G. verum</i>	-	-	O
<i>Geranium molle</i>	-	R	-
<i>Heracleum spondylium</i>	-	O	R
<i>Hypericum perforatum</i>	F	-	-
<i>Leucanthemum vulgare</i>	-	R	O
<i>Ophrys apifera</i>	O	-	-
<i>Pinus sylvestris</i>	-	-	R
<i>Plantago lanceolata</i>	-	O	O
<i>P. major</i>	-	-	R
<i>P. media</i>	-	-	R
<i>Rorippa sylvestris</i>	-	O	-
<i>Rubus fruticosus</i>	-	-	F
<i>Rumex obtusifolius</i>	-	-	R
<i>Senecio jacobaea</i>	R	-	-
<i>Solanum dulcamara</i>	-	-	O
<i>Taraxacum officinale</i>	R	-	-
<i>Tragopogon pratensis</i>	R	-	-
<i>Trifolium dubium</i>	-	-	R
<i>T. repens</i>	R	-	O
<i>Urtica dioica</i>	-	O	-
DAFOR scale: D (dominant) A (abundant) F (frequent) O (occasional) R (rare)			

Discussion

Throughout the study period, the abundance of individuals varied in response to changing emergence rates and resource availability at the study sites; factors which also influenced the behavioural patterns that were exhibited by both skipper species. Behavioural activity may also have been affected by weather conditions and further research should concentrate on this effect.

The number of *T. sylvestris* and *T. lineola* individuals that were observed on each recording day fluctuated throughout the study period (Fig. 2). However, individuals of both skipper species were observed on each recording day and simultaneous usage of each of the three study sites by individuals of both species occurred throughout the duration of the behavioural study. Therefore, there is overlap in the flight periods of the two species (Thomas & Lewington, 1991) and as Corke (1997) suggests, individuals of both species can be seen flying together within the same sites.

Although the flight periods of the two skipper species do overlap, *T. sylvestris* usually peaks slightly earlier than *T. lineola* (Emmet & Heath, 1989). The number of observations of both *T. sylvestris* and *T. lineola* gradually increased to reach a peak, before starting to decline as the study progressed and emergence rates decreased. However, the number of *T. sylvestris* individuals that were observed peaked one week earlier than the maximum number of *T. lineola* individuals which were sighted.

Both skipper species primarily spent their time basking, resting and nectaring (Fig. 3). Observations of other behavioural activities such as copulation and oviposition were infrequently recorded for either species during the study, partly because butterflies are less discernible when engaged in such activities, but also because these activities comprise only a minimal proportion of any butterfly's overall activity (Corke, 1997).

The different vegetative species in evidence at each of the three study sites determined how the sites were utilised by individuals of both skipper species. As Warren (1996) suggests, *T. sylvestris* females preferred to oviposit into the relatively loose leaf sheaths on the flowering stems of *H. lanatus*. *T. lineola* females, however, have been observed to exploit larval foodplants such as *P. pratense* and *D. glomerata* that have tighter leaf sheaths into which the overwintering *T. lineola* eggs are firmly contained (Porter, 1992). During the behavioural study, one *T. lineola* female was observed to utilise *P. pratense* for oviposition purposes and this species might have been more regularly used had it occurred in greater abundance (Table 2). However, *T. lineola* females were predominantly observed to oviposit within *A. elatius* leaf sheaths, utilising this species at both Spinney Verge and Lordships Pond, sites where it was frequently occurring.

Plant species which were used for nectaring purposes were not necessarily the most abundant species occurring in the survey areas. Frequently occurring plant species such as *A. eupatoria* and *R. fruticosus*, both from the Rosaceae family, were not used for nectaring purposes, indicating that individuals select nectar sources from particular botanical families. Proboscis length relative to the depth of the

flower corolla partly determines the plant species from which butterflies can imbibe nectar (Shreeve, 1992). Possessing long probosces with a 90 degree bend (Shreeve, 1992), *T. sylvestris* and *T. lineola* individuals were primarily observed to nectar on narrowly tubular flowers such as species from the Compositae (*C. nigra*, *C. arvensis*, *A. minus*), Labiatae (*B. nigra*, Self-heal *Prunella vulgaris* L.) and Leguminosae (*T. pratense*, *M. sativa*) families (Table 1).

In accordance with the findings of Warrington & Brayford (1995), the main nectar source for *T. sylvestris* in the study was *C. nigra*. Other plant species suggested as additional nectar sources for *T. sylvestris* such as *C. arvensis* and *T. pratense* (Goulson *et al.*, 1997) were also utilised during the study, but not to the same extent as *C. nigra*. At Spinney Verge, *C. arvensis* was not used for nectaring by either species because it was not flowering at this site during the study. *C. nigra*, however, was flowering in abundance within the survey areas at both Spinney Verge and Lordships Pond. *T. sylvestris* individuals are known to exhibit a significant degree of constancy (fidelity to a particular nectar source) to the plant species previously visited, to decrease time spent learning to extract nectar from different species (Goulson *et al.*, 1997). Constancy to *C. nigra* may have therefore been demonstrated by *T. sylvestris* individuals during the study.

T. lineola individuals also predominantly nectared on *C. nigra* at Spinney Verge and Lordships Pond. Additionally, in accordance with the observations of Preston & Westwood (1981) and Pivnick & McNeil (1985), *T. lineola* individuals utilised *T. pratense* and *M. sativa* for nectaring purposes. The mean duration of nectaring bouts by *T. lineola* individuals at Spinney Verge was greatest on *T. pratense* (Fig. 4), reflecting the time taken to imbibe more concentrated nectar.

Overall, *T. lineola* individuals spent most of their nectaring time utilising *B. nigra* (Table 1). At Tip Meadow, *B. nigra* was the dominant nectar source (Fig. 5) because *C. arvensis* was only flowering at the beginning of the study period and *A. minus* was only flowering at the end. Although these other plant species were used for nectaring by individuals of both skipper species at this site, opportunity for nectaring was predominantly limited to *B. nigra*. In an area containing both *B. nigra* and a variety of other nectar sources such as *C. nigra*, *T. lineola* individuals might therefore demonstrate a preference for *C. nigra* or another alternative nectar source.

Conclusions

Having established that resource availability influences behavioural activity, suitable habitats can be created on farmland to satisfy the requirements of both skipper species. Uncropped field margins, coppiced hedgerows and other non-cultivated areas should contain the preferred nectar sources such as *C. nigra* and *T. pratense*. Additionally, the provision of larval foodplants utilised by *T. sylvestris* and *T. lineola*, including *A. elatius*, could encourage breeding on agricultural land and should therefore be an integral element of any newly created habitats for grassland butterflies.

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